A Solar Occultation Instrument Suitable for Constellations of Small Satellites

Completed Technology Project (2017 - 2020)

Project Introduction

GLO: A Solar Occultation Instrument Suitable for Constellations of Small Satellites A key challenge in the Earth Science community is to exploit rapidly advancing microsatellite (microsat) technology in the task of providing the myriad of global measurements required to understand key processes. Microsats offer the possibility of inexpensive access to space, but also present payload design challenges resulting from issues such as limited size, weight, and power (SWaP) capacity and pointing capability. We propose a technology demonstration of an instrument we refer to as GLO (GFCR (Gas Filter Correlation Radiometry) Limb solar Occultation) which would measure the vertical profile of atmospheric trace species, with state-of-the-art accuracy. GLO contains 23 Visible Near Infrared (VNIR) and Short Wavelength Infrared (SWIR) spectral bands and measures 10 constituents plus temperature (T), yet fits into a 29x16x16 cm form factor, weighs 5.25 kg, consumes just 28.2 W during observations, and does not levy stringent pointing requirements to the spacecraft. GLO has heritage from HALOE and AIM/SOFIE, both highly successful solar occultation (SO) instruments, but (using recent advances in focal plane array (FPA), and cooler technology) is much smaller and requires substantially less power. In addition, it has significantly improved vertical resolution, pointing, and Upper Troposphere and Lower Stratosphere (UTLS) aerosol and T measurement capability, as well as much reduced sensitivity to aerosol contamination in trace gas retrievals. Novel aspects of the GLO sensor include: use of tactical, but space qualified, imaging FPAs (low cost); GFCR with imaging arrays (precise channel coalignment and registration); proxy GFCR for UTLS H_2O and O_3 (increased insensitivity to aerosol contamination in the UTLS); and VNR plus SWIR aerosol extinction measurement capability (aerosol extinction plus bulk properties). While GLO could have many applications (including, e.g., an inexpensive stratospheric monitoring sensor), we conceived it to probe a key but poorly documented component of the climate system, the UTLS, in a mission concept referred to as SOCRATES (Solar Occultation Constellation for Retrieving Aerosols and Trace Element Species). The goal of SOCRATES is to quantify the role of the UTLS in climate change. For SOCRATES, GLO measures T, radiatively active gases (H_2O, O_3, CH_4, N_2O), aerosols, and transport tracers (HDO, CO, HCN, HF, HCl) with vertical resolution (<1 km) and geographic sampling required for UTLS radiative forcing calculations. Satellite SO instruments provide high vertical resolution and precision, but sample only 2 latitudes per orbit. To mitigate this shortcoming, SOCRATES consists of a constellation of 6 GLO sensors, deployed from a single launch vehicle into orbits with slightly different mean altitudes. The dispersing orbits provide the required spatial and temporal sampling, with coverage from ±65° latitude. We have shown that the SOCRATES GLO constellation (6 sensors & microsats) meets all measurement complement, accuracy, vertical resolution, and spatial sampling requirements, and can be fabricated, launched, and operated in a 26-month mission within the NASA Earth Venture Mission cost capped budget. Under this proposal, we will refine the design and fabricate a complete prototype GLO sensor [identical in form,

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Organizational Responsibility

Responsible Mission Directorate:

Science Mission Directorate (SMD)

Lead Organization:

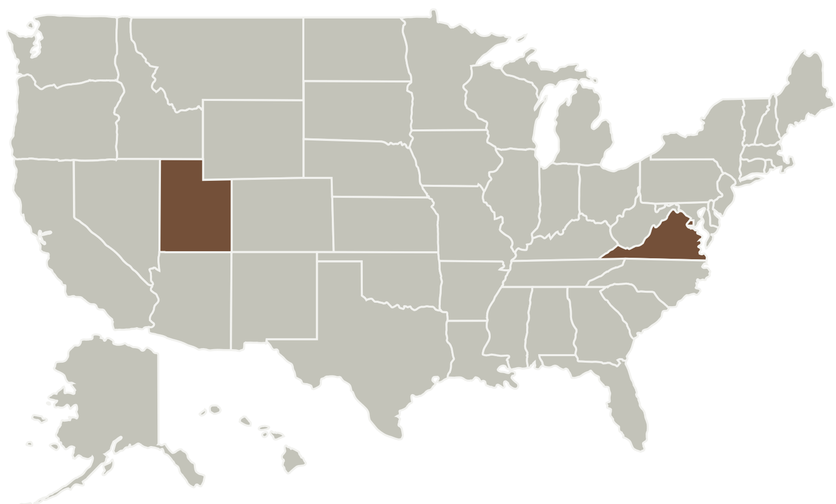
Virginia Polytechnic Institute and State University (VA Tech)

Responsible Program:

Instrument Incubator

fit and function to the SOCRATES/GLO sensor except for the use of non-space qualified (but functionally identical) components], perform functional and environmental tests to confirm it can meet SOCRATES measurement requirements, and validate the instrument concept through ground and balloon-based observations. This will provide a nearly complete demonstration of the GLO technology, and measurement approach and capabilities. The goal is to raise the GLO sensor technique and design from TRL 4 to TRL 6, providing risk reduction for the SOCRATES mission concept, and for the use of GLO in other missions.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Virginia Polytechnic Institute and State University(VA Tech)	Lead Organization	Academia Asian American Native American Pacific Islander (AANAPISI)	Blacksburg, Virginia

Primary U.S. Work Locations	
District of Columbia	Utah
Virginia	

Project Management

Program Director:

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Justin Carstens
Benjamin T Marshall
Joanna Sabal
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Brentha Thurairajah
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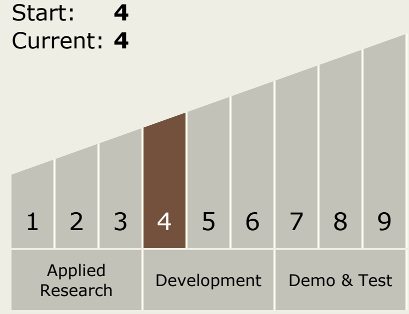
Technology Maturity (TRL)

Start: **4**
Current: **4**



Technology Areas

Primary:

- TX08 Sensors and Instruments

Continued on following page.

Technology Areas *(cont.)*

- └ TX08.1 Remote Sensing Instruments/Sensors
    - └ TX08.1.3 Optical Components

Target Destination

Earth